AeroMACS Interference Simulations for Global Airports

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AeroMACS Interference Issues

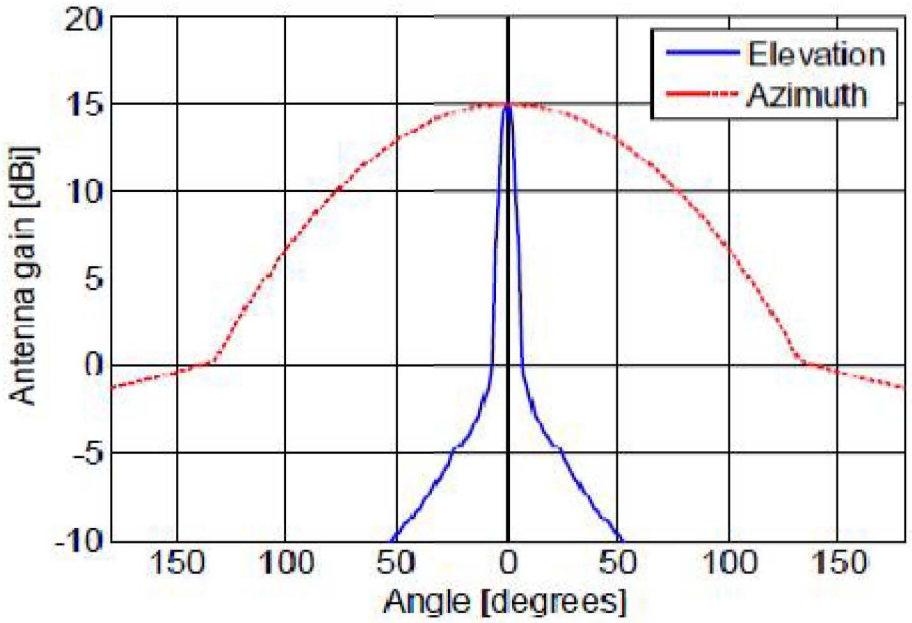
- AeroMACS (Aeronautical Mobile Airport Communications System)
  - Airport ground communications for next generation air transportation systems.
  - To be implemented in 5091-5150 MHz frequency band.
  - Must avoid interference with mobile satellite service (MSS) feeder uplinks.
- Interference Modeling
  - Performed with Visualyse Professional software.
  - Simulated configurations of AeroMACS antennas at 6207 worldwide airports.
  - Calculated resulting aggregate power at low earth orbit.
  - Determined limits on AeroMACS transmissions from airports so that the threshold of interference into MSS is not exceeded.

Interference Analysis Modeling

Modeling Procedure with Visualyse Professional:

1. Define antenna gain profiles.
2. Locate transmitters and receivers.
3. Specify bandwidth and frequency of carriers.
4. Set up propagation environment (basic transmission loss in free space, ITU-R P525).
5. Assign transmitter power.
6. Define links between transmitters and receivers.
7. Specify output desired, run, and analyze results.

AeroMACS Antenna Gain Profile



- 120^0 beamwidth sector antenna (ITU-R F.1336-2)
- Similar results with 80^0 beamwidth antenna used in Cleveland testbed experiments

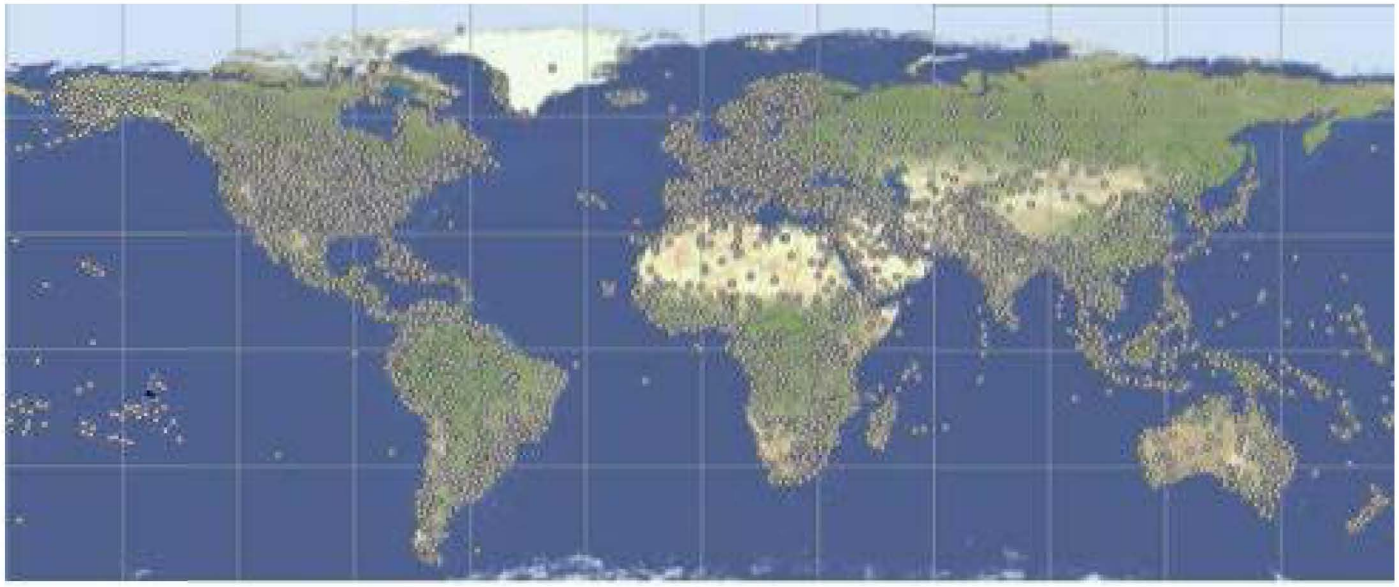
(Figure from Håkegård, "Compatibility Study in the AeroMACS Frequency Band," 2011 IEEE ICNS)

Antenna Transmission

- AeroMACS antennas transmit over 5-MHz channels.
  - Consider channel centered at 5100 MHz.
  - One of 11 channels available over 5091-5150 MHz band.
- Cumulative interference power calculated at LEO (1400 km).
- Determine 'hot spot' where aggregate interference power a maximum.
- Adjust transmitted power so that 'hot spot' is at threshold interference power.
- Threshold interference power = -157.3 dBW: corresponds to 2% increase of MSS satellite receiver's noise temperature.

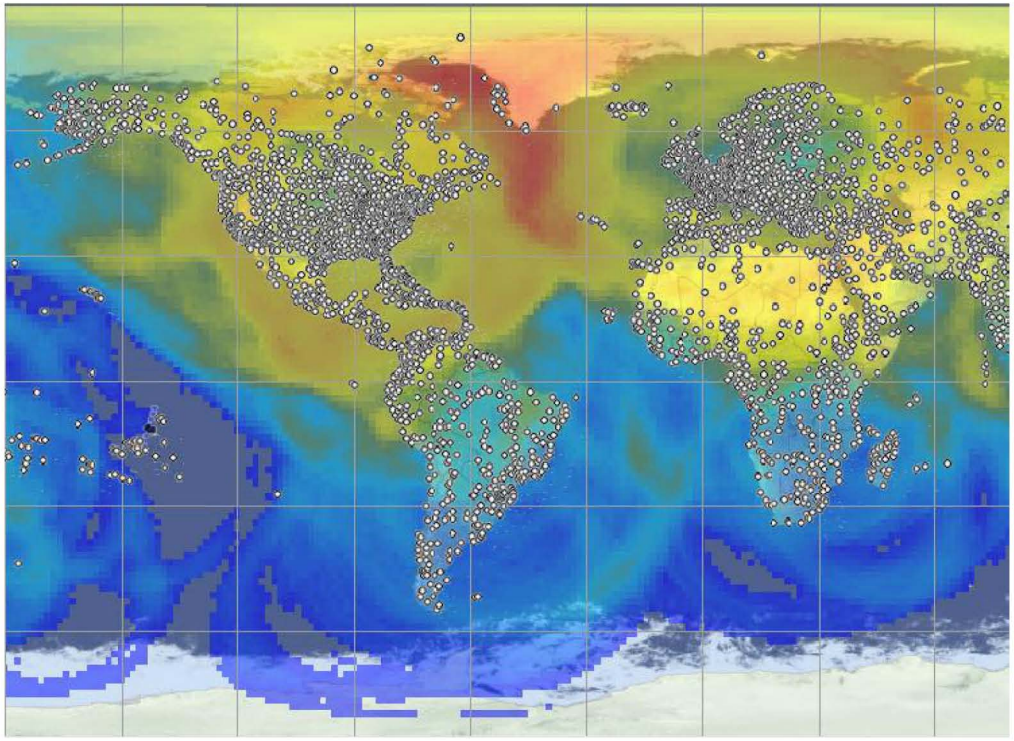
Worldwide Airport Database

- OpenFlights Airport Database (openflights.org/data.html)
- Used 6207 airports
  - Large Airports: 35 (USA) + 50 (Europe)
  - Medium Airports: 123 (USA) + 50 (Europe)
  - Small Airports: 1366 (North America) + 1249 (Europe) + 3336 (Rest of World)



Aggregate Interference Power at LEO

- Sample aggregate interference power distribution at 1400 km altitude
- Hot spot (red) generally occurs over Northern Atlantic



Scenario A Assumptions

- All airports use 120^0 beamwidth sector antennas (ITU-R F.1336-2) with 100% duty.
- No inter-channel interference.
- All of 85 large airports in U.S.A and Europe use 6 sector antennas on each of the 11 available channels.
- 173 medium airports in U.S.A. and Europe use 3 sector antennas on each of 6 channels. Thus 6/11 x 173 = 95 medium airports are operating on any given channel.
- 5951 small airports worldwide use 1 sector antenna on just 1 channel. Thus 1/11 x 5951 = 541 small airports are operating on any given channel.

Scenario A Results

- Randomly turned off 6/11 medium airports and 10/11 small airports to simulate interference for a single channel.
- Three runs with different random antenna directions
- Allowable transmitted power so that 'hot spot' is at threshold interference power:
  - 279.5 mW, 283.8 mW, 288.9 mW allowed per sector.
  - Large airports can transmit 275 x 6 = 1650 mW on each of 11 channels.
  - Medium airports can transmit 275 x 3 = 825 mW on each of 6 channels.
  - Small airports can transmit 275 x 1 = 275 mW on one channel.

Scenario B

- Same as Scenario A except small airports sectors can transmit only half as much power.
- Allowable transmitted power so that 'hot spot' is at threshold interference power:
  - 303.9 mW, 313.3 mW, 317.2 mW allowed per sector.
  - Large airports can transmit 300 x 6 = 1800 mW on each of 11 channels.
  - Medium airports can transmit 300 x 3 = 900 mW on each of 6 channels.
  - Small airports can transmit 300 x 1/2 = 150 mW on one channel.

Conclusions

- Ran 18 scenarios with Visualyse Professional interference software (presented 2 most realistic scenarios).
- Scenario A:
  - 85 large airports can transmit 1650 mW on each of 11 channels.
  - 173 medium airports can transmit 825 mW on each of 6 channels.
  - 5951 small airports can transmit 275 mW on one channel.
- Reducing power allowed for small airports in Scenario B increases allowable power for large and medium airports, but should not be necessary as Scenario A levels are more than adequate.
- These power limitations are conservative because we are assuming worst case with 100% duty.